WHAT IS CLAIMED IS:

1. A recombinant cell which expresses a holo-phycobiliprotein fusion protein comprising a heterologous-to-the-cell, fluorescent, first holo-phycobiliprotein domain fused to a heterologous protein domain, wherein the cell makes and comprises components: a bilin, a recombinant bilin reductase, an apo-phycobiliprotein fusion protein precursor of the fusion protein comprising a corresponding apo-phycobiliprotein domain, and a recombinant phycobiliprotein domain-bilin lyase, which components react inside the cell to form the holo-phycobiliprotein fusion protein.

2. The cell of claim 1, wherein the cell further comprises a heme and a heme oxygenase which react to form the bilin.

3. The cell of claim 1, wherein the cell further comprises a heme and a recombinant heme oxygenase which react to form the bilin.

4. The cell of claim 1, wherein the cell further comprises a heme and a recombinant heme oxygenase which react to form the bilin, and the recombinant heme oxygenase is HO1.

5. The cell of claim 1, wherein the heterologous protein domain is fluorescent and spectroscopically distinguishable from the first holo-phycobiliprotein domain.

6. The cell of claim 1, wherein the heterologous protein domain is fluorescent and spectroscopically distinguishable from the first holo-phycobiliprotein domain, and the heterologous protein domain comprises a heterologous-to-the-cell, fluorescent, second holo-phycobiliprotein domain.

7. The cell of claim 1, wherein the heterologous protein domain is fluorescent and spectroscopically distinguishable from the first holo-phycobiliprotein domain, and the heterologous protein domain comprises a phytochrome domain.

8. The cell of claim 1, wherein the heterologous protein domain is fluorescent and spectroscopically distinguishable from the first holo-phycobiliprotein domain, and the

heterologous protein domain comprises a green fluorescent protein (GFP) domain.

9. The cell of claim 1, wherein the heterologous protein domain is fluorescent and spectroscopically distinguishable from the first holo-phycobiliprotein domain, and the fusion protein provides fluorescence resonance energy transfer between the first holo-phycobiliprotein domain and the heterologous protein domain.

10. The cell of claim 1, wherein the cell is a mammalian cell.

11. The cell of claim 1, wherein the cell is a yeast cell.

12. The cell of claim 1, wherein the cell is a bacterial cell.

13. The cell of claim 1, wherein the cell is an E. coli cell.

14. The cell of claim 1, wherein the cell is in vitro.

15. The cell of claim 1, wherein the cell is in situ.

16. The cell of claim 1, wherein the bilin is phycocyanobilin (PCB), the reductase is 3Z-phycocyanobilin:ferredoxin oxidoreductase (PcyA), the apo-phycobiliprotein domain is phycocyanin α subunit domain, and the lyase is heterodimeric phycocyanin α subunit phycocyanobilin lyase (CpcE and CpcF).

17. The cell of claim 1, wherein the bilin is phycocyanobilin (PCB), the reductase is 3Z-phycocyanobilin:ferredoxin oxidoreductase (PcyA), the apo-phycobiliprotein domain is phycoerythrocyanin apo-α subunit domain, and the lyase is heterodimeric phycoerythrocyanin α subunit phycoerythrocyanobilin lyase (PecE and PecF), which further catalyzes the isomerization of the bound bilin to phycobiliviolin.

18. The cell of claim 1, wherein the bilin is phycoerythrobilin (PEB), the reductase is 3Z-phycoerythrobilin:ferredoxin oxidoreductase (PebA and PebB), the apo-phycobiliprotein

domain is phycoerythrin apo-α subunit domain, and the lyase is heterodimeric C-phycoerythrin α subunit phycoerythrobilin lyase (CpeY and CpeZ).

19. A method for making a holo-phycobiliprotein fusion protein, comprising growing the cell of claim 1 under conditions wherein the cell expresses the holo-phycobiliprotein fusion protein.

20. The method of claim 19, further comprising the step of isolating the holo-phycobiliprotein fusion protein.

21. The method of claim 19, further comprising the step of specifically detecting the holo-phycobiliprotein fusion protein.

22. The method of claim 19, further comprising the step of specifically detecting the holo-phycobiliprotein fusion protein within the cell.

23. A recombinant cell which conditionally expresses a heterologous-to-the-cell, fluorescent, first holo-phycobiliprotein domain, wherein the cell makes and comprises components: a bilin, a recombinant bilin reductase, an apo-phycobiliprotein domain, and a recombinant phycobiliprotein domain-bilin lyase, wherein at least one of the reductase, apo-phycobiliprotein domain and lyase is expressed upon activation of a targeted transcriptional promoter, whereupon the components react inside the cell to form the holo-phycobiliprotein domain, which provides a reporter for the activation of the promoter.

24. A method for making a holo-phycobiliprotein, comprising growing the cell of claim 23 under conditions wherein the cell expresses the holo-phycobiliprotein.